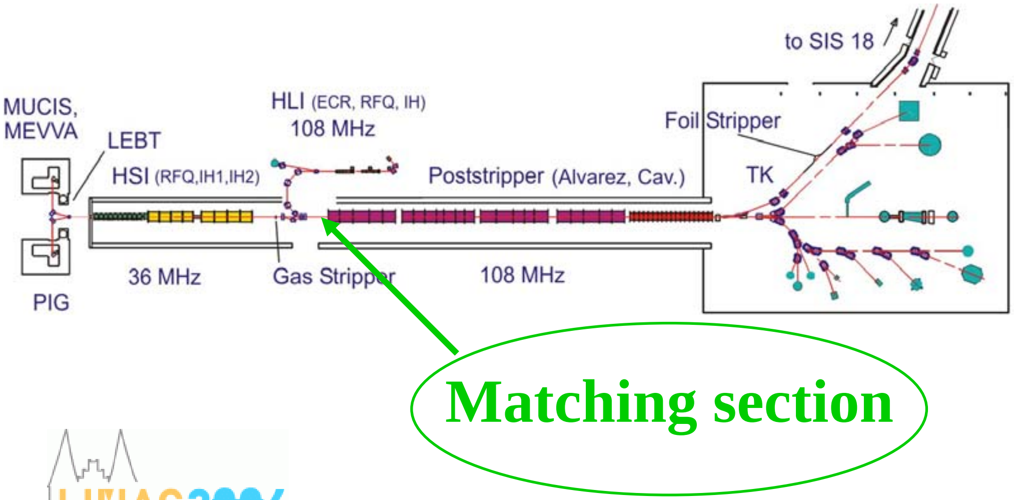
Investigation of the Beam Matching to the GSI-Alvarez DTL under Space Charge Conditions

S. Yaramishev, W. Barth, L. Dahl, L. Groening, S. Richter,
GSI, Darmstadt, Germany

The GSI-UNILAC – heavy ion, high current linac

36 MHz high current RFQ/IH-injector	15 emA U^{4+}
Gas stripper at an energy of 1.4 MeV/u	
108 MHz Alvarez postaccelerator up to 11.4 MeV/u	12.6 emA U^{28+}

UNILAC is designed to accelerate all ion species with ***m/z***< 8.5 and to fill the heavy ion synchrotron SIS up to its space charge limit.



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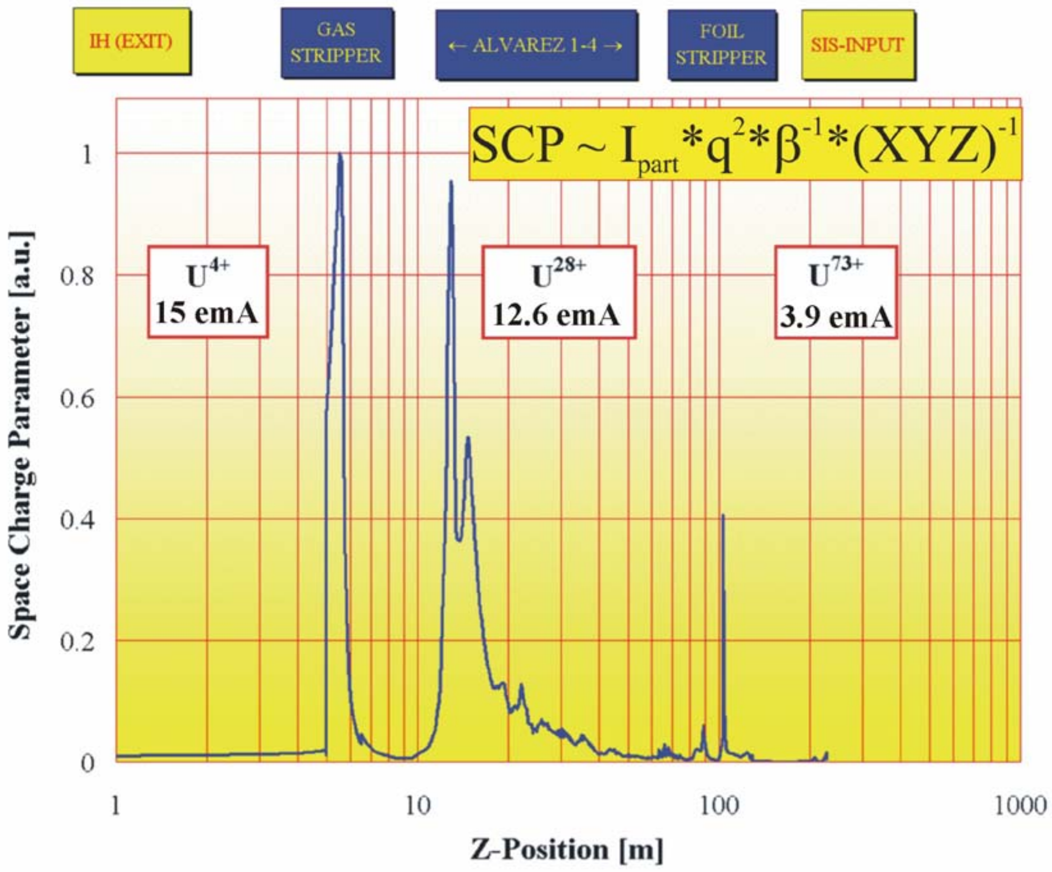
Increase current

Increase brilliance

Space charge parameter along UNILAC
(design uranium current)



Two significant peaks:

•**after stripping**:
current is up to factor of 7 higher for uranium beam

•**at the entrance of the 1st Alvarez tank**:
matching requires small beam size in all three dimensions

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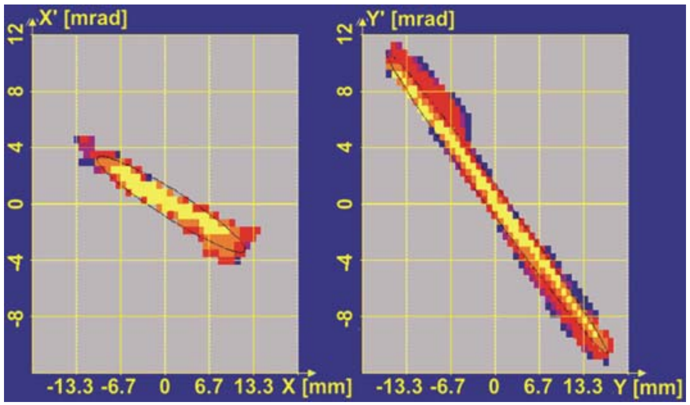
Complicate matching

Emittance growth

Particle losses

Matching section to the Alvarez postaccelerator

Measured transverse
beam emittances (4 emA U^{28+})

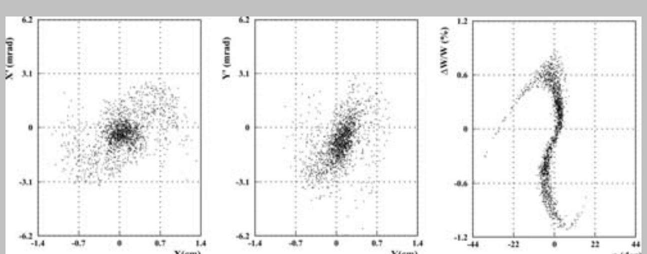


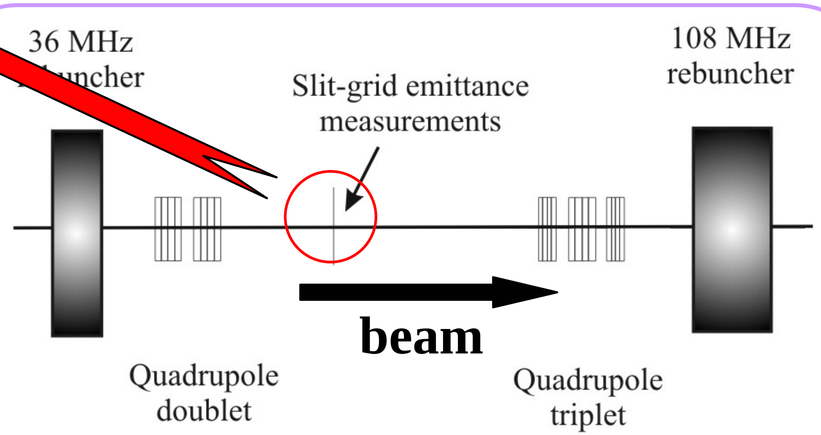
Systematic optimization procedure

Applying the procedure for the 4 emA U^{28+} beam, the losses along the Alvarez section were reduced from 8% to less than 1%, being the resolution of the transmission measurement.

Multi-particle distribution

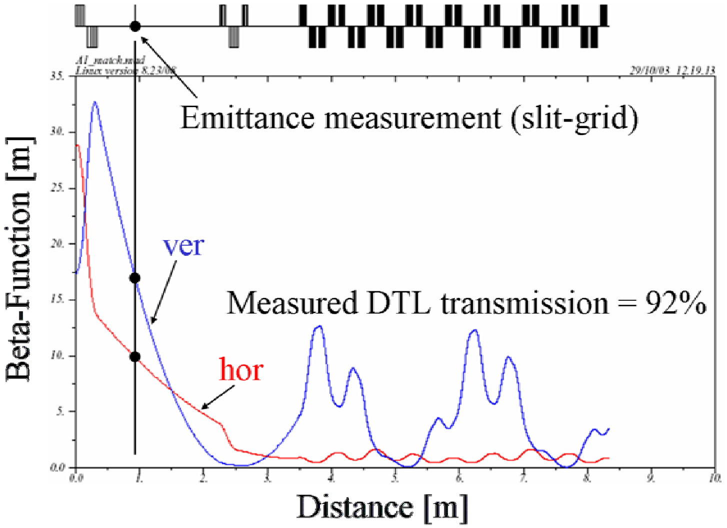
Beam emittances behind postaccelerator calculated with the DYNAMION code.



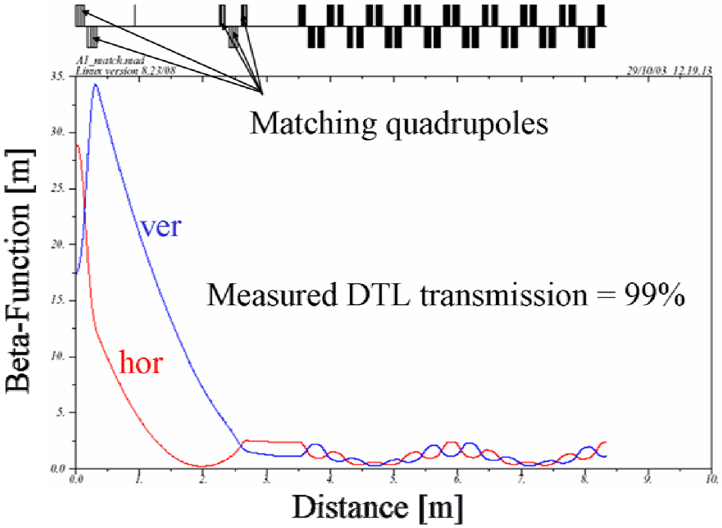


Systematic optimization procedure

Beta-functions in the matching section and first Alvarez cells ***before optimization***



Beta-functions in the matching section and first Alvarez cells ***after optimization***



Optimization of the quadrupoles in the DTL

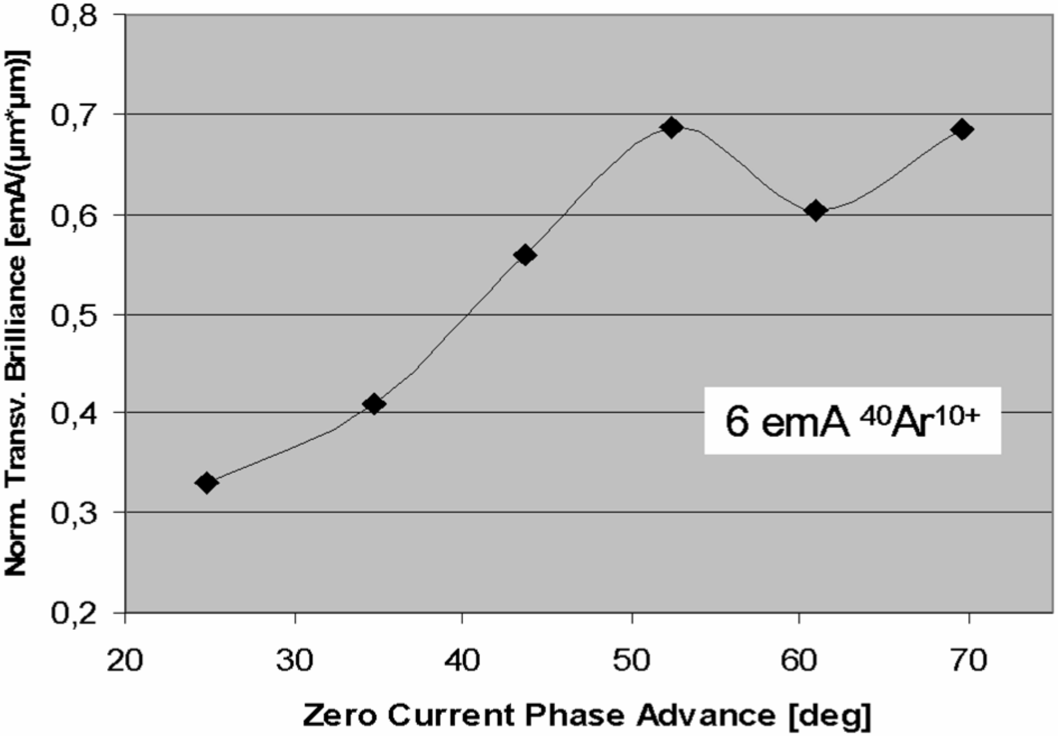
Increasing of the quadrupole strength leads to higher phase advance and improved beam quality

Space charge effects can be scaled from argon to uranium: 12.6 emA U^{28+} ≈ 6 emA Ar^{10+}

High ***m/z*** of $^{238}U^{28+}$ limits the maximum phase advance σ_0 <45° in the 1st DTL

For $^{40}Ar^{10+}$ ***m/z*** is less - experimental study is possible !

A phase advance σ_0>50° is required to increase the beam brilliance.



FAIR Project

Facility for the Antiproton and Ion Research at Darmstadt

L. Dahl	-	MOP05
L. Groening	-	MOP06
S. Richter	-	MOP07
S. Yaramishev	-	MOP08
W. Barth	-	TU103